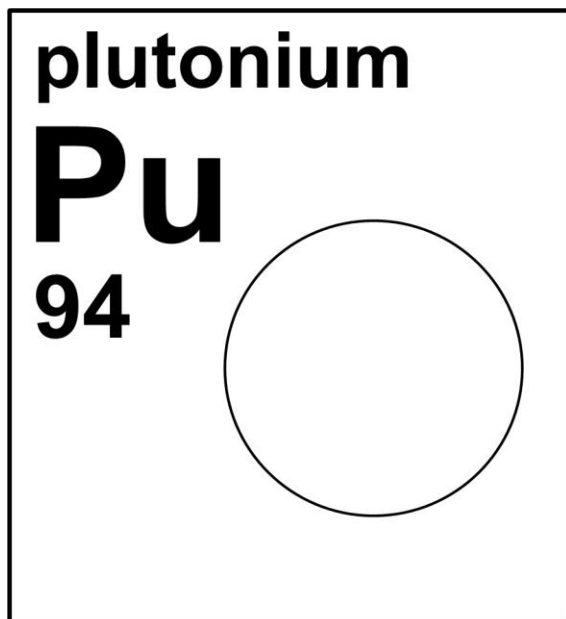





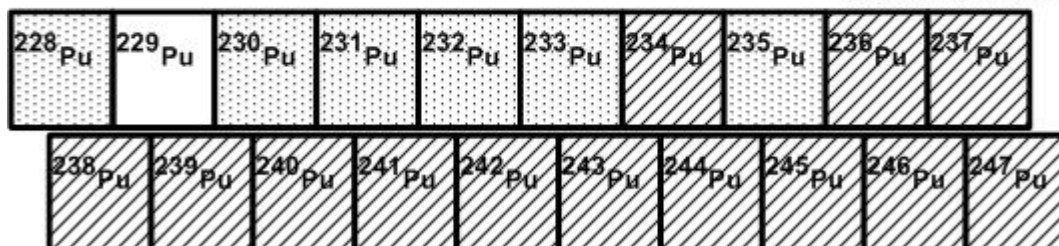
## plutonium



| Stable isotope | Atomic mass | Mole fraction |
|----------------|-------------|---------------|
| (none)         |             |               |

### Half-life of radioactive isotope

Less than 1 second   
 Between 1 second and 1 hour   
 Greater than 1 hour 



## Important applications of stable and/or radioactive isotopes

### Isotopes in nuclear research

- $^{239}\text{Pu}$  is easily made in nuclear reactors by bombarding  $^{238}\text{U}$  with neutrons. The  $^{239}\text{Pu}$  made by this reaction can itself be split by neutrons to release energy and is used for energy generation in nuclear reactors, which usually fission  $^{235}\text{U}$  in the reactor to produce two to three neutrons for the  $^{238}\text{U}$  or  $^{239}\text{Pu}$  to absorb.

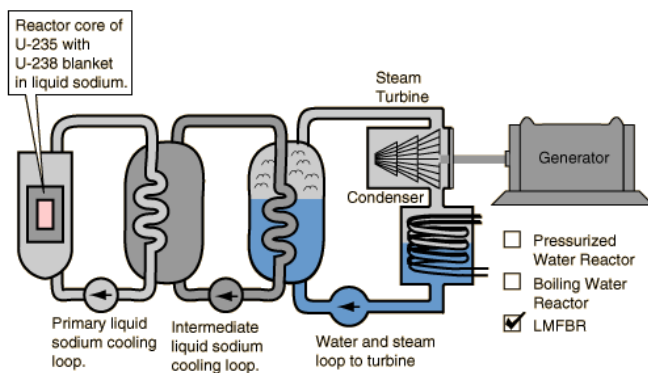


Figure 1: This is an illustration of a liquid metal fast breeder reactor which uses  $^{235}\text{U}$  and  $^{238}\text{U}$  to generate plutonium.

### Isotopes in industry

- 1)  $^{238}\text{Pu}$  is used in radiothermal generators as a heat source to produce electricity. These radiothermal generators are used to power unmanned spacecraft and interplanetary probes that venture too far from the sun to use solar power, such as the Cassini and Galileo probes.
- 2)  $^{239}\text{Pu}$  is used in nuclear reactors and weapons.
- 3)  $^{238}\text{Pu}$  has been used in the Apollo lunar missions as part of a nuclear battery. The SNAP-27 (systems nuclear auxiliary power) system produced approximately 75 W of electrical power at 30 VDC per unit. The energy source was a 2.5 kg rod of  $^{238}\text{Pu}$  providing thermal power of approximately 1250 W.
- 4) It is important to note that the plutonium produced as a by-product in a nuclear power reactor is created in its many isotopic forms, including  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{241}\text{Pu}$ , and  $^{242}\text{Pu}$ . This is known as "reactor-grade" plutonium. In contrast, "weapons-grade" plutonium contains almost pure (over 90%)  $^{239}\text{Pu}$ .  $^{239}\text{Pu}$  is created in a reactor that is specially designed and operated to produce  $^{239}\text{Pu}$  from uranium.

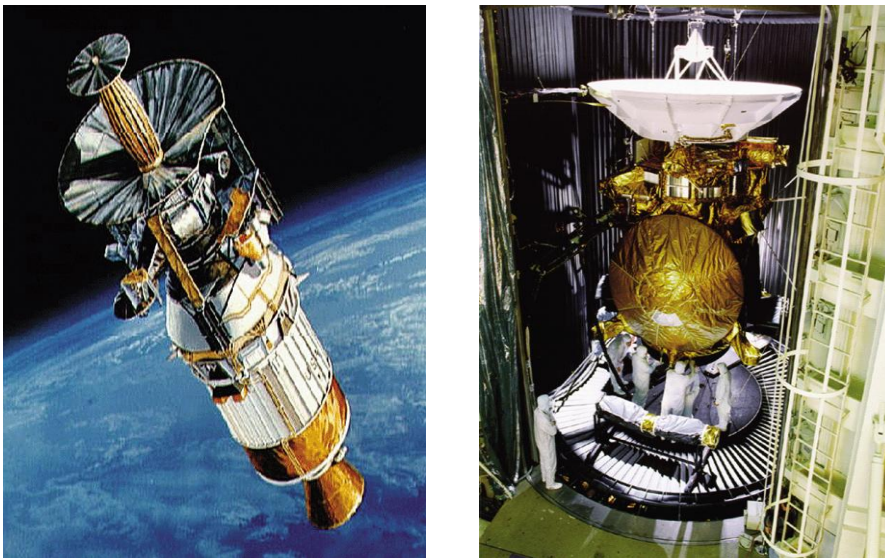


Figure 2: These are pictures of the Galileo (left) and Cassini probes (right). These are types of probes that are powered by radiothermal generators that use  $^{238}\text{Pu}$ .